

II

THE VISUAL ARTS AS LIBERAL ARTS



Representing the World

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On the face of it, a world of difference separates the official photograph of the Solvay Conference of 1911 (Fig. 2) from Raphael's *School of Athens* (Fig. 3), completed exactly four hundred years earlier. At the Solvay Conference, a conclave of Nobel laureates and other distinguished scientists actually talked to one another, with an enthusiasm we can see in the photograph itself; indeed, Marie Curie, the lone woman in the foreground, is so absorbed in a conversation with Henri Poincaré that neither of them pays attention to the camera that records their presence.¹ We may also recognize a very young Albert Einstein, second from the right, and, fourth from the right, Ernest Rutherford. Max Planck stands second from the left, and Louis De Broglie stands sixth. At the Solvay Conference of 1927, Einstein would deliver his famous remark to Werner Heisenberg that 'God does not play dice', but by then the participants were so well confirmed in their individual greatness that dialogue had given way to pronouncements. In 1911, however, Marie Curie and Poincaré can pore intently over a text that seems to puzzle them both.

This first Solvay Conference intended to assemble the greatest minds in chemistry, and it succeeded in that aim; although many of these people might have disputed their identification as chemists, without exception they would have called themselves scientists and their mode of procedure the scientific method. They are immortalized, appropriately, in the new medium of photography, their images captured by the light that, just at that moment, struck a treated piece of celluloid film. In the background we can see hints of another trick played by captured light: a portable screen suggests that the conference-goers must have illustrated their presentations by projecting lantern slides.² But technology, then as now, must also have been unreliable: candlesticks on the table suggest that the light cast by the electric bulbs overhead, and perhaps by the projector itself, might fail. Yet another play of light occurs with the help of two large mirrors: these open out, window-like, against the wood-paneled walls. Mirrors have of-



ten served the same purpose as windows at nighttime in dark, paneled rooms, most famously at Versailles.

Raphael's frescoed *School of Athens*, on the other hand, captures not a fleeting moment but an idea: something intangible, perhaps, but also something durable. Begun in 1509 and touched up in 1511, the painting was probably conceived as a *Triumph of Philosophy*.³ With marvelous immediacy, it shows the great philosophers of the world gathered, like the scientists of the Solvay Conference, in conversation. Rather than freezing an actual instant in time, however, *The School of Athens* collapses time onto itself, ranging philosophers who lived in the sixth century before the Christian era alongside those from Raphael's own early sixteenth century Anno Domini, as well as people from many of the centuries in between these two extremes.⁴ Although the gathering's nominal place is Athens, many of the philosophers assembled together beneath the painting's majestic vaults never set foot in Attica; they lived instead in places like Syracuse, Alexandria, Baghdad, and Rome. The building in which they stand is not a real building; we have reason to believe that it is the Temple of Philosophy described by the sixth-century writer Boethius in his *Consolation of Philosophy*, however closely it resembles the interior of Saint Peter's Basilica, designed by Raphael's relative Donato Bramante only a few years before, in 1506.⁵



Fig. 2 (left): Benjamin Couprie, *The Participants of the First Solvay Conference of 1911, Brussels*.

Fig. 3 (top): Raphael, *The School of Athens*, 1509-1511, Stanza della Segnatura, Palazzi Pontifici, Vatican City.

Unlike the little, portable photograph of the Solvay Conference (and like St. Peter's), *The School of Athens* is monumentally large and immovable; it is a painted wall that belongs to a particular building in a particular place. The fresco shows a certain number of ancient Athenians, but in fact it is rooted in the city of Rome, in the heart of the Vatican Palace, where it has stood for four hundred years as an announcement not much different from the announcement made, implicitly, by the Solvay Conference. Both of these images, one time-bound, one timeless, proclaim the birth of a new world of ideas. Both show the individuals who created that new world engrossed in conversation with one another; hence the creation of this new world is a collective rather than an individual enterprise. Both groups focused their primary attention on the workings of the universe, and to the best means by which such an investigation might be carried forward; both aimed to increase humanity's general store of knowledge for our common benefit. In many ways, then, the philosophers of the nascent sixteenth century were the same kinds of people who would become the scientists of the twentieth.

Both Raphael and Julius II, the pope who commissioned *The School of Athens*, believed in a world that could be, and had been, improved over time; so did most, if not all, of the conferees at Solvay.⁶ Cynical Diogenes, sprawled across the steps of the Temple of Wisdom, may not have been so optimistic about the future, nor

sullen Heracleitus, whom Raphael shows with the facial features of Michelangelo – not to mention the dogskin boots that Michelangelo wore so constantly that he was said to lose bits of his own skin whenever he took them off.⁷ But the general spirit of Raphael's great painting, like that of the less consciously artistic photograph, is one of almost ecstatic curiosity about the structure of the world, bolstered by a conviction that such curiosity will uncover things of marvelous beauty.

By now the *School of Athens*, despite a recent restoration, looks almost as venerable as the philosophies it enshrines; it is nearly half a millennium old. With portraits of philosophers spanning two thousand years of human history, the fresco presents creativity as a matter of tradition as well as invention, whereas the photograph of the Solvay Conference, with its new technology, its contemporary cast of characters, and a complete absence of references to bygone times or people, looks almost entirely forward. Yet there are radically innovative features to Raphael's image as well, features linking it as readily to the history of science as to the history of art.

In the first place, the imposing vaults of the Temple of Philosophy are presented in strict one-point perspective, a technique of representation that had been introduced to Italy less than a century earlier by Filippo Brunelleschi.⁸ Brunelleschian perspective applied a clear geometric formula to the representation of space, a formula that seemed to Brunelleschi and his contemporaries to mirror the actual mechanics of seeing. In a similar spirit and at virtually the same time as Raphael's fresco, Albrecht Dürer produced a famous woodcut showing an artist who uses a mechanical grid to insure the geometric accuracy of his perspectival foreshortening (Fig. 4).

Raphael makes a much more sophisticated use of perspective in the *School of Athens*. Within its sacred halls, the Temple of Philosophy is divided in two, its divisions cued by the marble statues of two gods, Apollo and Minerva, and the figures of two ancient Greek philosophers who were themselves accorded nearly immortal status in the sixteenth century: Plato and Aristotle.⁹ Plato, clutching a copy of his *Timaeus*, which speaks of the harmonics of the spheres, and Apollo with his lyre dominate the left side of the fresco, while Aristotle, holding his *Ethics*, rules the right side together with Minerva (the books are labeled in vernacular: *Timeo* and *Etica*). The painting's vanishing point is clearly to be found in its center, but that center is hard to identify securely, located as it is in the graceful folds of Plato and Aristotle's classical robes.

The obscurity of the vanishing point contrasts with the composition of Raphael's fresco for the opposite wall of the same room, *The Triumph of Theology* (Fig. 5, usually known today as the *Disputa del Sacramento*, the 'Debate about the Sacrament', but it is really a serene conclave). Here the artist has fixed his vanishing point in the center of a monstrance displaying the Host; the structure

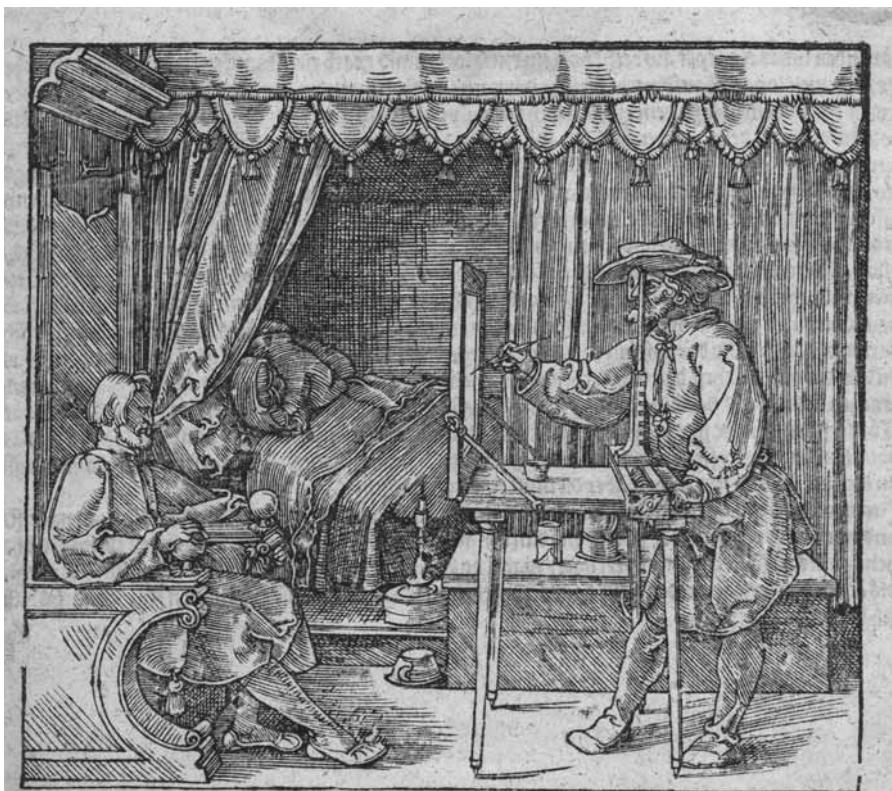


Fig. 4: Artist with mechanical grid, in Albrecht Dürer, *Underweysung der Messung, mit dem Zirckel und Richtscheit* (Arnhem 1603).

of the entire picture hinges on the Sacrament. So, too, Raphael seems to suggest, Christ, and more specifically the resurrected Christ who is embodied in the rite of the Mass, is the focal point of the world – in Raphael's day, 'world' was often used to mean the entire universe. Unlike this clear structure, which ranges high heaven with its golden rays and showers of cherubs above an image of God the Father, then the resurrected Christ, then the dove of the Holy Spirit, then the four Gospels, and then the Host, with a more anarchic crowd of saints and sinners below, the *School of Athens*, with its ancient Greeks, Egyptians, and Persians, and its medieval Muslims, lacks a comparable center: as thinkers unaffected by Christian revelation, they lack what Raphael and his patron, Pope Julius II (who commissioned these frescoes to decorate his private apartments), regarded as the central truth of human existence.¹⁰ The vanishing point is implicitly present, just as the wisdom of their philosophies is a real wisdom, but they have not experienced the full revelation of Christ. The Solvay

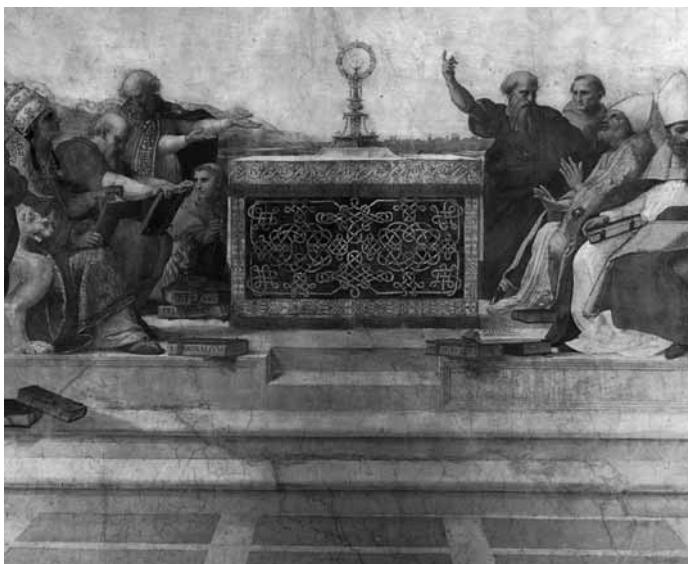


Fig. 5: Raphael, *The Triumph of Theology* (also known as the *Disputa del Sacramento*), Stanza della Segnatura, Palazzi Pontifici, Vatican City, detail.

Conference, of course, occurred in a more random world, one that would soon be thrown into the terrible chaos of the Great War. The commemorative photograph contains fewer compositional messages than Raphael's frescoes, and more fortuitous poses. Curie and Poincaré, for example, are surely rapt in discussion because that is how they spent their time, not because they have been asked to pose in this way.

Within the *School of Athens*, on the other hand, every posture is studied, and every posture tells a story. Plato, appropriately, clutches a copy of his cosmological dialogue, the *Timaeus*, labeled in Italian so that the greatest number of visitors will understand what is being portrayed here in the pontifical suite. Aristotle, gesturing out over our heads, holds his *Ethics*. Diogenes reclines on his side, just as Boethius describes him doing in the *Consolation of Philosophy*; Heraclitus, that inveterate poser of paradoxes, sulks on the side of the fresco that belongs to Plato. Pythagoras naturally takes up the Platonic side of the fresco, writing energetically in a tantalizingly illegible manuscript (there are no intelligible letters, only lines), while in front of him an angelic youth holds out a tablet with a musical diagram (Fig. 6). This diagram juxtaposes the musical interval of the diapason with the perfect number ten; in a single image it compresses two different kinds of information taken, perhaps, from two different passages in Vitruvius: the discussion of music in Book V, and that of perfect numbers in the preface to the same book. As a graphic presentation of multiple ideas, the diagram is compact and attractive; one of the first instances of a type of illustra-

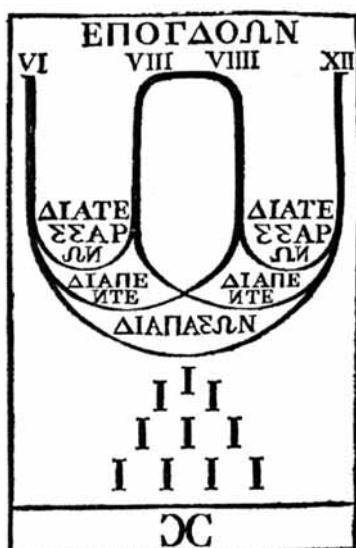


Fig. 6: The pythagorean table.

tion that will have a long, fruitful future in the service of philosophy, especially natural philosophy, and science.¹¹ Raphael had a genuine knack for this kind of visual representation, along with the visual representation of so much else, from painting to architecture to graphic arts. But he was hardly alone in exploring the possibilities offered by graphs and graphics. His exact contemporary Cesare Cesariano also distilled a passage from Vitruvius into a single image. Here, the ancient architect attempted to define the ideal length of a prose composition on geometric principles:

Pythagoras and those who followed his sect decided to write down their precepts using the principle of cubes; they thought that two hundred sixteen lines constituted a cube and that there ought to be no more than three cubes in a single written composition. Now a cube is a body, squared all round, made up of six sides whose plane surfaces are as long as they are wide. When it is thrown, the part on which it lands (so long as it remains untouched) preserved an immovable stability; the dice that players throw onto the gaming board are like this. The Pythagoreans seem to have taken the image of the [literary] cube from dice, because this particular number of lines, landing like dice on any side whatsoever, will there produce immovable stability of memory.¹²

Following this lead of Vitruvius, Cesariano captured the idea of 'cubic composition' in the image of a die (Fig. 7).¹³

When Vitruvius discussed 'cubic composition,' he may have concluded that 216 lines of papyrus text were the ideal amount of information for a reader to absorb in a single sitting, and therefore the most effective unit into which a writer can divide a composition, but the actual divisions in his own treatise seldom reflect this ideal—Vitruvius had too much to say on too many subjects.¹⁴ Two thousand years after Vitruvius, Robert Silvers, the editor of the *New York Review of Books*, defined the ideal length of an article as three thousand six hundred words. This is about twice the length that Vitruvius commends—but it is remarkably close to the actual length of the rhetorical prefaces with which Vitruvius begins each of his *Ten Books* [that is, papyrus scrolls; we would call them chapters] on Architecture, and both of them, in turn, hew close to the Pythagorean limit of three 'cubes.'

Cesare Cesariano himself is an interesting case: an architect who lived in Milan and translated Vitruvius without ever having seen the marvels of ancient Rome, like the Colosseum and Pantheon—although of course Vitruvius was born too early to have seen them either. To illustrate the section of the *Ten Books* in which the ancient architect set out the criteria for evaluating a classical building, 'soundness, utility, and attractiveness,' Cesariano therefore turned to his own idea of a classic: the cathedral of Milan (Fig. 8).¹⁵ To our eyes, and to the eyes of Cesariano's contemporary, Raphael, this building, begun in 1386, with its elongated proportions and lacy spires, is Gothic rather than classical in style. In one sense, then, Ce-

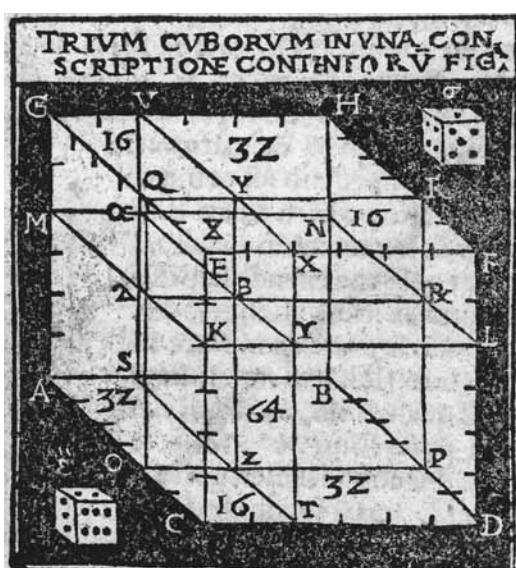


Fig. 7: Image of a die from
C. Cesariano, *Di Lucio Vitruvio
Pollione de architectura libri decem:
traducti de latino in vulgare* (Como
1521).

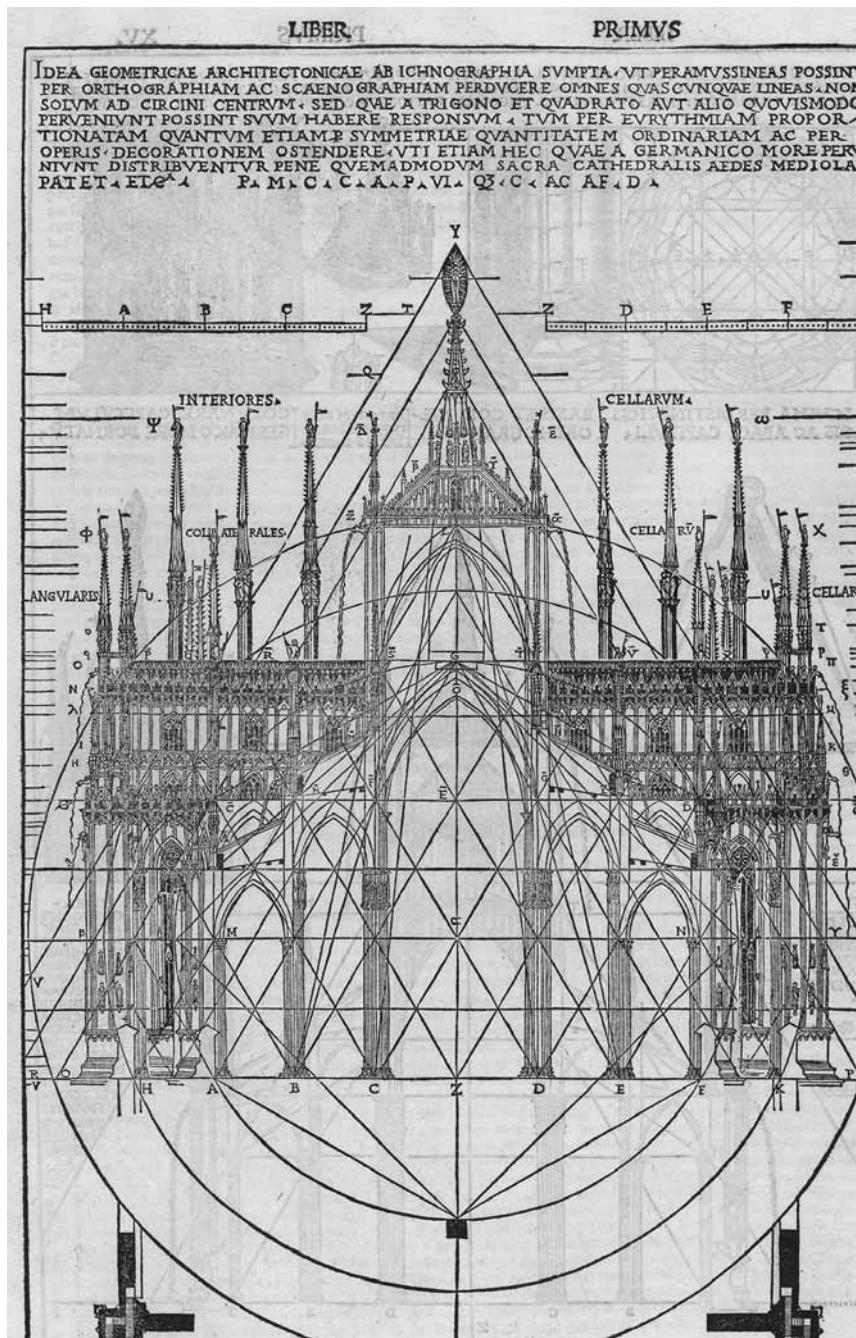


Fig. 8: Façade of Milan Cathedral from C. Cesariano, *Di Lucio Vitruvio Pollione de architectura libri decem: traducti de latino in vulgare* (Como 1521).

sariano's visual vocabulary was strikingly archaic for his era—he did not draw an evident distinction between classical and medieval architecture as his contemporaries in Florence and Rome were doing. In another sense, however, he understood that medieval architects still held to the same classical principles as Vitruvius, and that their works, like the cathedral of Milan, were also, in their own way, strong, useful, and attractive—and on this point, in fact, Raphael agreed with him.¹⁶

As a graphic artist, however, Cesariano belonged to the sixteenth century's most innovative avant-garde, and few of his contemporaries could match the creative ways in which this Milanese architect could lay out a printed page, or display different varieties of information in a concise image.

Cesariano had been taught by the same mentor as Raphael: the painter and architect Donato Bramante, whose talents also included composing vernacular poetry, playing the lute, and reciting Dante. This extraordinary Renaissance man appears in the lower right-hand portion of the *School of Athens* in the guise of the geometer Euclid, bent over a mathematical diagram; both Euclid and — implicitly — Bramante belong, then, to Aristotle's side of the painting, along with the astronomers and the more practical, empirical philosophers. Bramante left Milan for Rome in 1500; in the Eternal City he began a close study of ancient Roman construction that led him to create modern buildings whose elegance and refinement were regarded by many contemporary critics, Raphael and Cesariano among them, as equal to the great works of antiquity.¹⁷

Bramante's view of the classical style, and of Vitruvius, would become the prevailing view, first in Rome, and then in the world, first for Raphael, and then for Vignola, Palladio, and through Palladio for the English and American classical tradition: Inigo Jones in the seventeenth century, Thomas Jefferson in the eighteenth, and McKim, Mead and White in the twentieth.¹⁸ Although Bramante's only surviving written work may be an extremely funny mock-rustic poem about Rome's antiquities, the *Antiquarie Prospettiche Romane*, he was a towering intellect, whose casual conversation with Raphael and others may have given us our concept of the classical orders, Doric, Ionic, and Corinthian, and certainly gave us our ideas about the majesty of ancient Roman interior space.¹⁹ Raphael's Temple of Wisdom owes an immense debt to Bramante's vision, especially to his plans for the rebuilding of St. Peter's Basilica, and in their own day Bramante's works were revolutionary. The sheer novelty of his architecture is hard for us to recreate now, because it so quickly became the definitive style for monumental buildings, both sacred and secular, throughout the Christian world.

Bramante's vision of ancient architecture emphasized the clarity of its overall design and the distinctiveness of its component parts, but there were other strains in early sixteenth-century thought that aimed for intricacy, secrecy, and occult truth. A good example of that taste for convolution can be seen on the altar front of Ra-

phael's *Triumph of Theology* (its popular name now is *Disputa del Sacramento* 'Debate about the Sacrament', but in the center of the Vatican of Julius II that debate had surely been resolved once and for all) (Fig. 5).²⁰ The altar at the fresco's center is covered by a cloth intricately embroidered in golden knots from a single cord, a reminder that one of the new luxury arts to come in with the fifteenth century was that intricate creation of knots known as lace.²¹ The making of lace is a matter of great complexity and long-term strategy; a lacemaker, no less than a general, must anticipate what her threads will be doing in a remote future and deploy them with that future in mind. To an extent most ancient writers would not like to admit, the grid plans of ancient architecture and city planning derived from the looms on which women wove the social fabric along with more literal cloth.²² Similarly, in Malta, one of the centers for lace in the early modern world, the most highly paid woman was the Grand Master's lace mistress. 'The world is bound with secret knots,' declared the Jesuit Athanasius Kircher on the title page of his book on *The Magnetic Kingdom of Nature, Magneticum Naturae Regnum*, published in 1665.²³

Theology, indeed, presented an increasingly knotty problem for thinkers of the early modern period. Cesare Cesariano's universe was still bounded by the sphere of the fixed stars, but the universe for another son of the sixteenth century, Giordano Bruno, had burst forth into infinity.²⁴ Bruno made his leap by the sheer power of thought, shortly before the telescope began to confirm his findings. When Galileo Galilei began to point his telescope toward the heavens, his discoveries expanded not only the boundaries of the known universe, by identifying the moons of Jupiter, but also, once again, the boundaries of graphic art. In some editions of his *Starry Messenger* of 1612, the book in which he first reported his findings with the telescope, the stars of the Pleiades, now revealed as many more than the traditional six (Fig. 9),



Fig. 9: The Pleiades, from Galileo Galilei, *Sidereus nuncius* (London 1653).

seem to burst the margins of the printed page; in the same way, Bruno's ideas were bursting apart the music of the spheres.²⁵ Bruno's influence on Galileo was more profound than the younger man liked to admit (and not only because Bruno had been burned at the stake in 1600); when Galileo insisted, for example, that the Bible should be used as a source for moral guidance rather than as a treatise on nature, he was actually repeating an idea that Bruno had voiced in his own cosmological dialogue, *The Ash Wednesday Supper*.²⁶

Both Bruno and Galileo had the misfortune to live in the aftermath of the Protestant Reformation, when European positions on religion began to harden on all sides. The Catholic response to Martin Luther and John Calvin was the self-reforming Council of Trent, the great gathering that originally aimed to heal the break of the Reformation and ended up instead by reinforcing it.²⁷ Along with pronouncements on dogma, the Council also issued edicts about art and architecture, and it was in this quandary that the painter Michelangelo Merisi da Caravaggio – although we now know for certain that he was born in Milan – came down to Rome.²⁸ Caravaggio has often been identified as a realist, a painter who took pains to show his subjects' dirty feet, who used prostitutes and cutpurses as his models. And yet a painting like his *Deposition* (Fig. 10), now in the Vatican Museum but intended for a chapel in the church of Santa Maria in Vallicella, performs a far more complex operation. In one sense, this is a painting that aims to show Christ's burial just as it was; the heroic figure of Jesus is explicitly wrapped in the Shroud of Turin, which also appears in the stucco decoration of the chapel that was the painting's original destination.²⁹ The figures are nearly life size; in the oblique light of their original setting, they must have seemed uncannily three-dimensional. And yet at the same time they recreate the pose from a famous ancient Roman sarcophagus, now in the Capitoline Museums, depicting the burial of the ancient Greek hero Meleager.³⁰ Caravaggio, the great realist, shows here that he is also a classicist at heart. In trying to show how this event happened in Roman-occupied Judea, in the reign of the emperor Tiberius, under the procurator Pontius Pilate, the painter, by now familiar with original works of ancient Roman art, gives his figures the movements of ancient Romans, and carefully shows Christ wrapped in the long linen shroud, twice a man's height, that is still venerated in Torino. Yet these figures are clothed in early seventeenth-century clothing; if they are of ancient Roman times, they are also of Caravaggio's time, and the time of the painting's first viewers. Similarly, Caravaggio's *Calling of St. Matthew* (Fig. 11, page 88) puts Jesus and Peter, clad in their Roman togas, just inside the door of a dark little moneychangers' shop, calling 'follow me' to men who dress and act like Caravaggio's contemporaries, people who live sixteen centuries later. These scenes therefore show



Fig. 10: Michelangelo Merisi da Caravaggio, *The Deposition*, 1602-1603, oil on canvas, 300 x 203 cm, Pinacoteca, Vatican City.



Fig. 11: Michelangelo Merisi da Caravaggio, *The Calling of Saint Matthew*, 1599–1600, oil on canvas, 322 x 340 cm, Contarelli Chapel, San Luigi dei Francesi, Rome.

more than the call and the suffering of Jesus; they also strive, urgently, to reveal the deep, truthful harmonies that underpin reality, no less than the much neater diagram of the diapason in Raphael's *School of Athens*. Caravaggio's thoroughly human subjects wear their imperfections in much the same spirit as the moon in Galileo's *Starry Messenger*, whose pockmarked face the great astronomer portrayed in unprecedented detail (Fig. 12); by carefully tracing the outlines of lunar craters, Galileo, an exceptional artist, made it increasingly difficult to argue that the spots on the moon's surface were clouds in the Earth's atmosphere – our satellite was not the perfect crystal sphere that Aristotle declared it should be. Yet neither the imperfection of humanity nor the imperfection of the Moon disturbed Caravaggio's conviction that human-

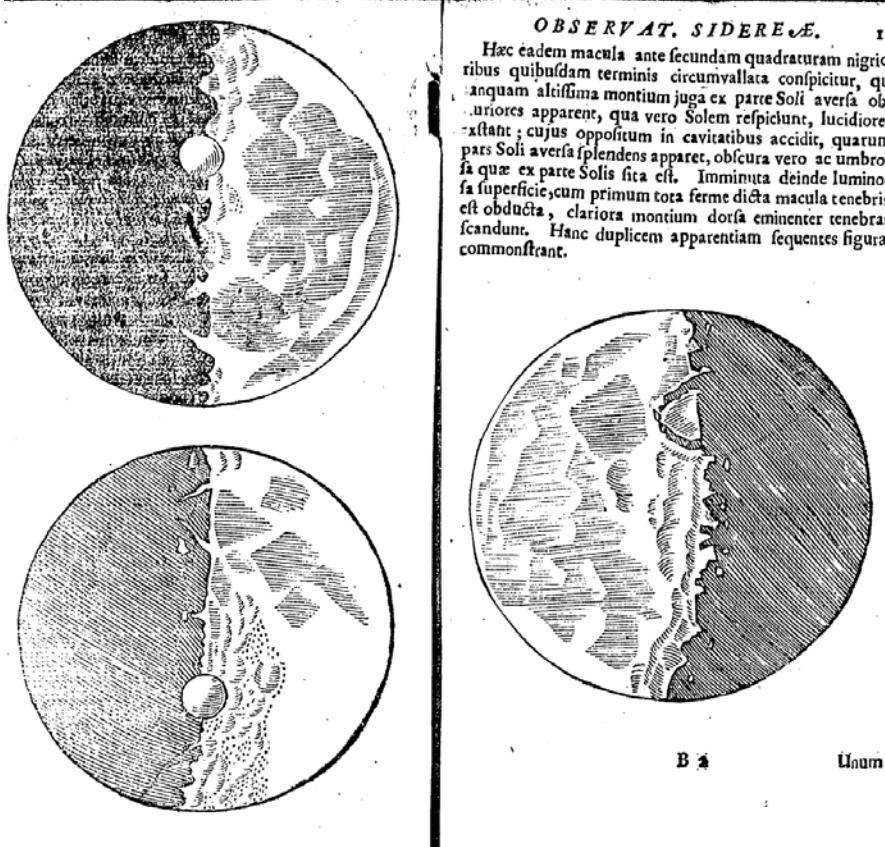


Fig. 12: The Moon, from Galileo Galiei, *Sidereus nuncius* (London 1653).

ity could be redeemed by faith nor Galileo's conviction that the universe was fantastically beautiful.

Indeed, Galileo, however inclined he may have been to show the moon warts and all, was also his own kind of classicist; by couching his later works in the form of dialogues, he harked back to Plato and, although once again he would never admit it, to Giordano Bruno, his forerunner in so many ways. Dialogue was a medium that allowed both Bruno and Galileo to discuss as well as to expose their arguments, especially by showing the process by which intelligent but initially skeptical characters like the Londoner Mr. Smitho in Bruno's *Ash Wednesday Supper*, or the sober Venetian Sagredo in Galileo's *Dialogue on the Two Chief World Systems*, could be won over by the brilliance of the author's

alter egos: Bruno's Teofilo and Galileo's Salviati. Stefano Della Bella's title page for Galileo's *Dialogue* (Fig. 13) is itself a kind of *School of Athens*, even if one member of its conclave, the dimwitted Simplicio embodying Aristotle, hardly deserves his place in the Temple of Wisdom.



Fig. 13: Stefano della Bella, title page from Galileo Galilei, *Dialogo ... sopra i due massimi sistemi del mondo Tolemaico, e Copernicano* (Florence 1632).

We have already noted Galileo's mastery of print as a medium; beyond his pungent use of language, his publications deftly exploit art together with prose and the appearance of the printed page. And here again, Galileo looked back to the heretic Giordano Bruno who had made similar use of printed publication to disseminate his ideas, although he did so on a much lower budget, with woodcuts from his own hand rather than professional engravings by a master artist like Stefano Della Bella. Over the course of the sixteenth and seventeenth centuries, the possibilities for publishing began to expand as rapidly as the amount of philosophical knowledge that print was called upon to disseminate; in Catholic countries, the Inquisition was quick to take notice. As a result, printers flocked to Protestant cities; Amsterdam, in particular, became one of world's greatest centers for the publication of books and engravings. Catholic authors took advantage of Amsterdam's free presses no less than their Protestant and Jewish counterparts, none more so than the seventeenth-century German Jesuit, father Athanasius Kircher (1601-1680), who in his own day ranked as a scientist in the same league as Galileo (Fig. 14, next page). One of Kircher's Amsterdam imprints shows him in his most distinctive haunt: the museum he assembled within the halls of Rome's Jesuit College beginning in 1651, and which survived more or less intact until the unification of Italy in 1870.³¹ The museum hall still exists, although its fresco decorations have been whitewashed away, as do a surprising number of the objects we see on display in the engraving. When we examine both the setting and the surviving objects, we can see that the whole engraved image of Kircher's museum is perfectly accurate in its proportions, with one exception: the human figures gathered in its foreground are about half as tall as they should be. The obelisks we see ranged behind Father Kircher and his guests still exist; made of wood, they are all only a meter high. The skeleton in the background has also survived, but it belongs to a human fetus rather than a full-sized adult. The Temple of Wisdom in Raphael's *School of Athens* is truly monumental, but this room is monumental only because its occupants have been reduced to the size of leprechauns. The clever trick of perspective and miniaturization works so convincingly, however, that Giambattista Piranesi would borrow it for his terrifyingly grand views of Roman ruins—and most architects' drawings today still glorify their work by exaggerating the size of their own buildings and reducing the people who will use those buildings to the stature of ants. On the timeline between Raphael's Temple of Wisdom, where questions about nature are part of philosophy, and the paneled room of the Solvay Conference, where nature is the province of science, Athanasius Kircher and his Museum stand somewhere in the middle – and perhaps they stand more on the scientific side than the writers of the 1909 *Encyclopaedia Britannica* thought when they described Father Kircher as 'a man of wide and varied learning, but singularly devoid of judgment and critical discernment'. Kircher's reputation suffered for much of the twentieth century because his efforts



Fig. 14: The Musaeum Kircherianum, from Georgius de Sepibus, *Romani collegii Societatis Jesu musaeum celeberrimum* (Amsterdam 1678).

to represent reality included both a theological and what we would call a scientific purpose rather than a single-minded pursuit of science; however, the death of Giordano Bruno and the imprisonment of Galileo would have reminded Kircher that any departure from theological orthodoxy in his own time and place could pose a mortal risk. In fact, however, with daring, subterfuge, and an outrageous sense of humor, he departed regularly from the standard truths of Jesuit teaching.

Kircher may be best known today for his Baroque diagrams, like his vision of the microcosmic man from his treatise on music, the *Musurgia universalis* (Fig. 15), but there was a core of practical empiricism in the man as well. His interest in geology was sparked by his year in Malta between 1637 and 1638, when he was able to climb both Etna and Vesuvius, but many of his ideas must have come from

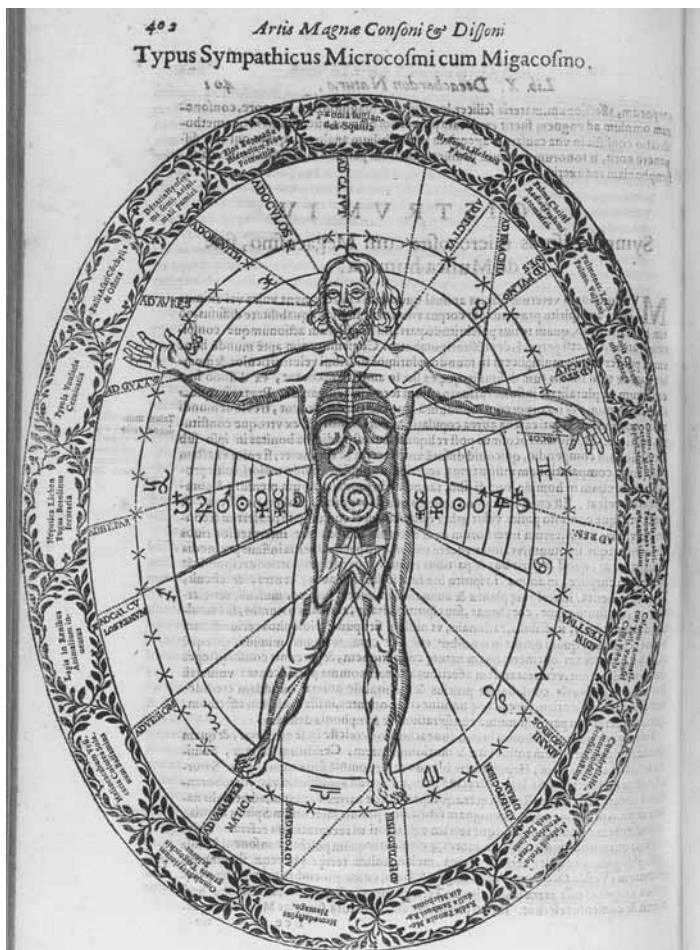


Fig. 15: The Microcosmic Man, from Athanasius Kircher, *Musurgia universalis sive ars magna consoni et dissoni in X. libros digesta* (Roma 1650).

the limestone plateau of the Maltese islands themselves, from places like Dwejra Bay on the island of Gozo. Fossilized sand dollars such as those at Dwejra crystallized his interest in fossils in general; his geological masterpiece, the *Mundus subterraneus* of 1665, devotes several pages to engravings of them. The geological strata and fault lines that are particularly visible on the limestone plateau of the Maltese Islands eventually led Father Kircher to formulate the forerunner of our own theory of plate tectonics, and to explain the loss of Atlantis by the process we now identify as subduction. He regarded the Earth as an imperfect sphere riddled with veins of fire, air, and water. So too were the Moon and Sun, whose troubled faces he had seen with telescope and helioscope (a telescope that projected the Sun's image). Kircher's geology even underpins one of Baroque Rome's most beloved works of art, Gianlorenzo Bernini's *Fountain of the Four Rivers*, commissioned for the Jubilee of 1650 although it was finished in 1651, several months behind schedule (Fig. 16). Beneath an Egyptian obelisk, rivers represent-



Fig. 16: Gianlorenzo Bernini,
Fountain of the Four Rivers, 1648-1651,
Piazza Navona, Rome.

ing four continents gush forth from an enormous water reservoir, what Kircher called a hydrophylacium, hidden, like the sources for all the world's rivers, underneath a great hollow mountain. The similarities between Bernini's travertine mountain and the formations that Kircher imagined after seeing the fault lines and stratified layers of Malta show the work of two great observers, and two great imaginations.

The *Fountain of the Four Rivers*, in a real sense, is also a representation of the world, one that Kircher especially, more than perhaps Bernini, conceived as a melding of two forces: what he called the vicissitude of nature, and the eternal truths of religion.³² The obelisk is made of granite, a supremely hard stone, and topped by a dove and cross of gilded bronze, materials to symbolize the eternal glory of heaven and the durability of true faith. Below, everything is porous, from the surface of the travertine to the very nature of the creatures clinging to the water-gushing rocks. Real weeds sprout among Bernini's carved foliage, proof of Kircher's theory that the world was infinitely fertile as well as of Bernini's artistry.³³ The fountain was erected to celebrate a ceremony of Christian repentance and forgiveness, the Jubilee, that descended from a similar rite in Judaism; it was also a monument to the recent end (in 1648) of the dreadful Thirty Years' War, with its million victims.³⁴ As a single comprehensive image of the world and its ways, this important work of urban renewal is not much different from the allegory on the title page of Kircher's later book, the *Ars magna sciendi* (Fig. 17, page 106), where divine wisdom rules over a land whose eroded soil is carried by a river into the sea, but built up again by a spewing volcano. In Kircher's view, the physical world moved in an endless circle of change, guided by a transcendent, steady higher truth. If he were to be transported magically into Raphael's *School of Athens*, this redoubtable empiricist would still stand firmly on the side of Plato.

In *Obeliscus Pamphilii*, the volume that Father Kircher published to celebrate the fountain of the four rivers – and at the same time to advertise his own forthcoming books on Egyptology and geology – he concentrated on translating the hieroglyphic inscriptions on the obelisk's sides, a skill in which he claimed unique proficiency, and not entirely without justification; his was the intuition that modern Coptic would provide the key to ancient Egyptian.³⁵ But perhaps the strongest impact of the book resides in the power – or at least the shamelessness – of its advertising, from the title page that presents the middle-aged, black-clad author as a heroic youth to the constant hints that still greater works are poised to emerge from his remarkably fertile pen. Kircher's Jesuit censors called ceaseless and critical attention to his propensity to brag, but it never seems to have had the slightest effect on him.³⁶ The public, meanwhile, begged for more, and more they got.

In 1666, when Kircher and Bernini joined forces a second time to combine statue and obelisk, they also played a Jesuitical joke on the Dominicans who had



Fig. 17: Title page from Athanasius Kircher, *Ars Magna Sciendi* (Amsterdam 1669).

found the artifact in their garden.³⁷ Bernini's drawings for the project still exist, and he toyed with several designs for a pedestal to carry the obelisk, including a figure of Hercules staggering under its weight. He and his sponsor, Pope Alexander VII, eventually opted for a more reassuring – and more structurally sound – solution on a site that is literally built on the shifting silt of the River Tiber (Fig. 18). A well-fed elephant lofts his Egyptian needle above inscriptions declaring that only a robust soul is fit to bear the burden of wisdom, but his knowing smirk seems likely to stem from the fact that all the while he is turning his posterior toward the door of the Dominican convent of Santa Maria Sopra Minerva, the



Fig. 18: Gianlorenzo Bernini, *The Obelisk of Santa Maria Sopra Minerva*, 1667, Rome.

place where Giordano Bruno resided for a time in 1576 and Galileo stood trial for heresy in 1633. On the other hand, the elephant could hardly turn his tail toward the church next door, and it would be nearly as rude to turn it toward passersby on the street. Or so Bernini might have argued, indeed the placement of sculpted animals in Roman piazzas always reflects mature consideration of the direction in which they aim their various parts. The reign of Alexander VII, who was elected in 1655, had been ushered in by a series of dramatic events, from the arrival of the newly converted Queen Christina of Sweden – of whom the disappointed Pope wrote ‘non è bella’ in his diary – to an outbreak of plague.³⁸ He had good reason to ask artist Pietro da Cortona to paint him an image of a guardian angel (Fig. 19) and may have felt more like the old man in the background hovering on a precipice in a dark and stormy night than like the child who strides forward with innocent faith in the foreground. In the meantime, however, his friend Father Kircher was seeing the plague through empirical eyes, training several varieties of microscope on the problem. As the disease raged in Trastevere, the Pope imposed a rigid quarantine, encouraged by Kircher, who was convinced that the trouble could ultimately be traced to what he called ‘little worms’ and we would eventually call a microbe.³⁹ The plasmodium *Yersinia pestis* was too small to be detected by the instrument that Kircher called a *smicroscopium*, and the Jesuit censors delayed publication of the book in which he detailed his findings, but *Scrutinium pestis* came out in 1668, the first step in a chain of research that would lead to the understanding, if not the eradication, of the bubonic plague. The board of censors, for their own part, had acted in a way consistent with modern scientific or scholarly peer reviewers; Jesuits were not trained as medical doctors, and they did not want Kircher’s book to draw conclusions about medicine without having a real physician’s approval.⁴⁰ Pope Alexander’s reaction to plague in 1655, then, involved both the invocation of guardian angels and the imposition of quarantine, and it is testimony to the courage — and to the faith — of his nephew Flavio Chigi and two other cardinals that they made repeated visits into the quarantined area without wearing protective plague suits.⁴¹ There was no other way for people to know that they were cardinals.

Skill with the microscope enabled Kircher’s contemporary Francesco Redi to refute another of the seventeenth century’s persistent controversies: the question of spontaneous generation.⁴² Kircher, for example, believed that insects and reptiles were created from straw, dung, and the fertile power of sunbeams; the weeds on the Fountain of the Four Rivers testify to that fertile force, which Kircher called *panspermia rerum*, the universal seeds of things.⁴³ Both of them, like their

Fig. 19: Pietro da Cortona, *The Guardian Angel*, 1656, oil on canvas, 225 x 143 cm, Galleria Nazionale d’Arte Antica, Rome.



Dutch colleague Antonie van Leeuwenhoek, were horrified to discover what a remarkable menagerie lived within normal everyday objects, from peaches and melons to the insides of their own mouths and the surface of their own skins. Redi, however, was finally able to identify fly eggs in dung and thereby put strict limits on the generative powers of *panspermia rerum*; the term would not be used again until the Swedish chemist Svante Arrhenius, who won the newly minted Nobel Prize in 1903, to discuss the origins of life in the universe.⁴⁴

In general, we can see the early modern period oscillating between allegorical and metaphorical means of representing the world, and what we might identify now as a more empirical approach. Athanasius Kircher, of course, stands gloriously in between the two, with his intricately fanciful diagrams of great correspondences that no longer mean much to us, and the orderly presentation of data, to which we attribute much of our own standard of physical and intellectual life. It may not be surprising to find a great early modern empiricist like the entomologist (and Amsterdam resident) Maria Sibylla Merian (Fig. 20) presenting her visually ravishing studies of insect metamorphosis as simultaneous comments on the transitory nature of life; she was, after all, the member of a strongly pietistic Protestant sect, the Reformation's version, then, of an Athanasius Kircher.⁴⁵



Fig. 20: Maria Sibylla Merian,
Tulip.



Fig. 21: Jacopo Torriti, *Coronation of the Virgin*, 1295, Santa Maria Maggiore, Rome.

But even today, modern scientific representations of our world and its nature still make use of art and allegory. The great gas clouds that the Hubble space telescope has revealed giving birth to stars are visible to us only because their colors have been artificially enhanced; created no less than the wholly distinctive reds and oranges that only Maria Sibylla Merian could ever extract from pigments. And a now-common diagram in chemical kinetics presents the reaction of two molecules as an event that takes place in an energy field conceived as a landscape; here the hills and valleys are made not of earth but of pure energy. Our blue planet is the product of scattered light rather than the crunching in a mortar of lapis lazuli, but the ends of the universe have not changed their colors for all that; a thirteenth-century *Coronation of the Virgin* (Fig. 21) pictures a round heaven in stripes of blue and gold, perhaps only because these are the two most precious pigments, perhaps because of the color presented by sun and sky. For Raphael in his *Triumph of Theology* of 1508, as for Titian's *Assumption of the Virgin* from ten years later, deep space is light gold, the color of the metal electrum, as the prophet Ezekiel declared when he described his vision:

And I looked, and behold, a whirlwind came out of the north, a great cloud, and a fire unfolding itself, and out of the midst thereof as the color of amber, out of the midst of the fire.

Now we think of deep space as black, and smelling of sizzling beefsteak, and the music of the spheres, as Stanley Kubrick's film *2001* suggested, is the $\frac{3}{4}$ time of the *Blue Danube Waltz*. Our representations of the worlds beyond still refer back in the end to this shifty world around us, because it is here that we live our lives. The Solvay Conference, no less than the *School of Athens*, is a lofty edifice filled with quirky human beings, an overarching universe roiling with errant ideas. The history of those ideas is not only a history of science; it is always, equally, a history of the humanities, those two fields of study that were once partners in philosophy and are still inextricable partners in thought. Today, no less than in the yesterday of the *School of Athens*, Plato still jostles Aristotle, and the still point between them is still caught in a swirling mass of drapery.

Notes

- 1 See the official website of the Conseils Solvay at URL: <http://www.solvayinstitutes.be/Conseils%20Solvay/WhatConseilsSolvay.html>.
- 2 The first lantern slides were projected in the seventeenth century; see, for example, Athanasius Kircher, *Ars Magna Lucis et Umbræ* (Romae: Herm. Scheus, 1646).
- 3 See Marcia Hall, ed., *Raphael's School of Athens* (Cambridge and New York: Cambridge University Press, 1997); Bram Kempers, 'Words, Images, and all the Pope's Men: Raphael's Stanza della Segnatura and the Synthesis of Divine Wisdom,' in Iain Hampsher-Monk, Karin Tilmans & Frank van Vree, eds., *History of Concepts: A Comparative Perspective* (Amsterdam: University of Amsterdam Press, 1998), 131–165.
- 4 Pythagoras, holding a tablet on the lower left, lived in Southern Italy in the sixth century BC; contemporaries depicted in the painting include Raphael himself, standing second from the right on the right-hand edge of the painting; his relative and mentor Donato Bramante, the bald man bending over a geometric diagram in the right foreground, and Tommaso Inghirami, the portly man in blue standing to the far left and reading a book.
- 5 This interpretation was put forth first by Roland Fréart de Chambray, *Idée de la perfection de la peinture* (Le Mans, 1662); a modern edition by Frédérique Lemerle-Pauwels and Milovan Stanić, *Roland Fréart de Chambray, Parallèle de l'architecture antique avec la moderne: suivi de Idée de la perfection de la peinture* (Paris: École Nationale Supérieure des Beaux-Arts, 2005). Giovanni Pietro Bellori's influential *Descrizione* follows this interpretation; Kempers, however, puts their identification into historical perspective, Kempers, 'Words, Images, and All the Pope's Men,' 141–3.
- 6 This *plenitudo temporum* is evoked in Paolo Portoghesi, *Roma del Rinascimento* (Venice: Electa, 1971), 16–24.
- 7 The dogskin boots were noted by Giorgio Vasari in his *Life of Michelangelo*: 'Alle gambe invecchiando portava di continovo stivali di pelle di cane sopra lo ignudo i mesi interi, che quando gli voleva cavare poi, nel tirargli ne veniva spesso la pelle' ('as he grew older he wore dogskin boots over bare feet for months on end, so that when he wanted to remove them, often, in pulling them off, his skin came off as well').
- 8 In a vast bibliography, the following are still excellent sources: John White, *The Birth and Rebirth of Pictorial Space* (London: Faber and Faber, 1957); Samuel Y. Edgerton, *The Re-*

- naissance Rediscovery of Linear Perspective* (New York: Basic Books, 1975); Martin Kemp, *The Science of Art: Optical Themes in Western Art from Brunelleschi to Seurat* (New Haven and London: Yale University Press, 2002).
- 9 In a vast bibliography, see note 3 above.
- 10 Kempers, 'Words, Images, and All the Pope's Men' is particularly interesting in this regard.
- 11 The classic work on this subject is Edward R. Tufte, *The Visual Display of Quantitative Information*, 2nd Edition (Graphics Press, 2001).
- 12 Vitruvius, *De Architectura*, V.praef. The translation is mine; Ingrid D. Rowland and Thomas Noble Howe, eds., *Vitruvius Ten Books on Architecture* (Cambridge and New York: Cambridge University Press, 1999), 63.
- 13 Cesare Cesariano, ed., *Di Lucio Vitruvio Pollione De architectura libri decem: traducti de latino in vulgare, affigurati, comentati, & con mirando ordine insigniti: per il quale facilmente potrai trouare la multitudine de li abstrusi & reconditi vocabuli a li soi loci & in epsa tabula con summo studio expositi & enucleati ad immensa utilitate de ciascuno studioso & beniuolo di epsa opera* (Como: Gottardo de Ponte, 1521), fol. LXXII recto. On Cesariano, see, most recently, Maria Luisa Gatti Perer and Alessandro Roveretta, *Cesare Cesariano e il classicismo del primo Cinquecento* (Milan: Università Cattolica, 1996).
- 14 My word counts for papyrus scrolls are extremely rough, given the lack of preserved Latin texts from the time of Vitruvius (late first century B.C.). One line of Latin papyrus text normally seems to have contained one line of Latin hexameter verse, and transcribed Latin prose texts from Herculaneum seem to contain similar numbers of words and letters; I have therefore based my calculations on a comparison of Vergil and Vitruvius. See some general remarks on Latin papyri and their script in Knut Kleve, 'The Latin Papyri in Herculaneum,' in Adam Bülow-Jacobsen, ed., *Proceedings of the 20th International Congress of Papyrologists, Copenhagen, 23-29 August, 1992* (Copenhagen: Museum Tusculanum Press, 1994), 382-383.
- 15 Cesariano shows the ground plan at folio XIII verso; elevations at XV verso and XVI recto. The famous triad of *firmitas, utilitas, et venustas* comes from Vitruvius, *De Architectura*, I.3. Translation Rowland and Howe, p. 26.
- 16 See Francesco Paolo di Teodoro, Raffaello, *Baldassar Castiglione e la Lettera a Leone X. Con l'aggiunta di due saggi raffaelleschi* (Bologna: Minerva Edizioni, 2003).
- 17 Raphael credits Bramante with equaling the ancients in his letter to Pope Leo X: 'a' dì nostri l'architectura sia molto svegliata e venuta assai proxima alla maniera dell'i antichi, come si vede per molte belle opere di Bramante'. Text cited from Ingrid D. Rowland, 'Raphael, Angelo Colocci, and the Genesis of the Architectural Orders,' *Art Bulletin* 76 (1994), 103.
- 18 See the collected papers in *Studi Bramanteschi, atti del Congresso Internazionale di studi bramanteschi, 1970*, (Milan: Electa, 1974); Francesco Paolo Di Teodoro, ed., *Donato Bramante, ricerche, proposte, riletture* (Urbino: Accademia Raffaello, 2001); Arnaldo Bruschi, *Bramante Architetto* (Rome and Bari: Laterza, 1969).
- 19 For Bramante's authorship, see Doris Fienga, 'The Antiquarie Prospetiche Romane Composto per Prospectivo Melanese Depictore. A Document for the Study of the Relationship between Bramante and Leonardo da Vinci,' (Ph.D. diss., University of California at Los Angeles, 1970), so also Ingrid D. Rowland, *The Culture of the High Renaissance. Ancients and Moderns in Sixteenth-century Rome* (Cambridge: Cambridge University Press, 1998), 105-108. Giovanni Agosti and Dante Isella disagree, pointedly, in their edition of the *Antiquarie Prospetiche Romane* (Milan: Guanda, 2004), esp. p. lxxiii.

- 20 For some reason, many English-speaking writers also put an accent on the final letter of *Disputa* (a convention I mistakenly followed in an early article), but the word is stressed on its first syllable.
- 21 A remarkable, erudite account of the history of lacemaking is that of Consiglia Azzopardi, *Antique Maltese Lace of the time of the Order 1534 – 1798: Artistic and Technical Appreciation* (M.Phil. Thesis, University of Malta, 2002), written by the great lace expert of the Maltese Islands.
- 22 See Pier Nicola Pagiara, 'Vitruvio da testo a canone,' in Salvatore Settimi, ed., *Memoria dell'antico nell'arte italiana*, Vol. III (Turin: Einaudi, 1986), 5-86; Ingrid D. Rowland, 'From Vitruvian Scholarship to Vitruvian Practice,' *Memoirs of the American Academy in Rome* 50 (2006), 9-27.
- 23 Athanasius Kircher, *Magneticum Naturae Regnum* (Amsterdam: Johann Jansson, 1667), title page.
- 24 Ingrid D. Rowland, *Giordano Bruno, Philosopher/Heretic* (New York: Farrar, Straus and Giroux, 2008).
- 25 See Ingrid D. Rowland, *The Ecstatic Journey: Athanasius Kircher in Baroque Rome* (Chicago: University of Chicago Libraries, 2000), 72-74.
- 26 Galileo's declaration that Scripture should not be used as a basis for the discussion of nature is found in his letter to the Grand Duchess Christina of Lorraine (1615), *Lettera a Cristina di Lorena, Granduchessa di Toscana*, in Galileo Galilei, *Opere*, ed. Antonio Favaro (Florence: Giunti-Barbera, 1968), vol. V, 309-348; Giordano Bruno's assertion comes from his dialogue *The Ash Wednesday Supper, La Cena de le Ceneri*, of 1584.
- 27 Paolo Sarpi's introduction to his history of the Council is scathing; Pietro Soave Polano (Paolo Sarpi), *Istoria del Concilio Tridentino* (London, 1619).
- 28 Caravaggio's birth notice was discovered in Milan in 2007 by Vittorio Pirami, a retired executive who had always been interested in the history of art; see the press release for the exhibition 'Caravaggio a Milano', URL: www.caravaggioamilano.it/pdf/atto_nascita.pdf.
- 29 See Helen Langdon, *Caravaggio: A Life* (London: Chatto and Windus, 1998), 241-246.
- 30 Ancient Roman sarcophagi showing the death of Meleager, visible in several versions in Rome, inspired Renaissance paintings of the *Entombment of Christ* since the early fifteenth century (notably Raphael's *Entombment* in the Borghese Gallery, Rome), and Leon Battista Alberti praised a version of the sarcophagus visible in Florence in his *Della Pittura*, here cited from the translation by John R. Spencer, *Leon Battista Alberti on Painting* (New Haven: Yale University Press, 73): 'In every one of his members, he appears completely dead—everything hangs, hands, fingers, and head; everything falls heavily.'
- 31 Maristella Casciato, Maria Grazia Ianniello & Maria Vitale, eds., *Encicopedismo in Roma barocca: Athanasius Kircher e il Museo del Collegio romano tra Wunderkammer e museo scientifico* (Venice: Marsilio, 1986); Eugenio Lo Sardo, ed., *Athanasius Kircher: Il Museo del Mondo* (Rome: De Luca, 2001); Idem, *Giorgio Di Sepi, Il Museo del Collegio Romano di Athanasius Kircher* (Naples: Scriptaweb Online Publishing, 2006); Ingrid Rowland, 'Il geroglifico del mondo: Athanasius Kircher e il suo Museo,' in *Il Rinascimento Italiano e l'Europa*, Vol V, *Le Scienze* (Angelo Colla Editore, 2008), 218-232 (trans. Francesco La Nave); in press; English version online in *Humanist Art Review* III (2008), URL: <http://www.humanistart.net>.
- 32 Ingrid Rowland, 'Th' United Sense of th' Universe: Athanasius Kircher in Piazza Navona,' *Memoirs of the American Academy in Rome* 46 (2001).
- 33 Ingrid Rowland, 'Athanasius Kircher, Giordano Bruno, and the Panspermia of the Infinite Universe,' in Paula Findlen, ed., *Athanasius Kircher, the Last Man who Knew Everything* (New York: Routledge, 2004), 191-206.

- 34 See Konrad Repgen, 'Negotiating the Peace of Westphalia: A Survey with an Examination of the Major Problems', in: *1648: War and Peace in Europe*: 3 vols. (Catalogue of the 26th exhibition of the Council of Europe, on the Peace of Westphalia), Klaus Bußmann and Heinz Schilling (eds.) on behalf of the Veranstaltungsgesellschaft 350 Jahre Westfälischer Friede (Münster and Osnabrück, 1998), vol. I, 355-372. *Acta Pacis Westphalicae* is an immense project devoted to every aspect of the Peace; the website at URL: <http://www.pax-westphalica.de/> gives details of its extensive publications.
- 35 See Lo Sardo, *Athanasius Kircher*; idem, *The She-Wolf and the Sphinx: Rome and Egypt from History to Myth*, exhibition catalogue (Milan: Electa Editrice, 2008).
- 36 Harald Siebert, 'Kircher and his Critics: Censorial Practice and Pragmatic Disregard in the Society of Jesus,' in *Athanasius Kircher, the Last Man who Knew Everything*, ed. Paula Findlen, (New York: Routledge, 2004), 79-104.
- 37 Lo Sardo, *Athanasius Kircher*; Brian Curran, Anthony Grafton, Pamela Long and Benjamin Weiss, *Obelisk* (Cambridge, MA: MIT Press, 2009).
- 38 The relationship between Kircher and Chigi has yet to be discussed in depth. They saw each other with some frequency whenever they were both in Rome; see Chigi's diaries, edited by Konrad Repgen, *Diarium Chigi, 1639-1651*, *Acta Pacis Westphalicae*, Ser. III, Abteilung C, Diarien (Münster: Rheinisch-Westphälische Akademie der Wissenschaften, 1984).
- 39 Fabio Troncarelli, 'La paura dell'idra. Kircher e la peste di Roma,' in Casciato a.o., *Encyclopedismo in Roma Barocca*, 139-150; Martha Baldwin, 'Reverie in the time of Plague: Athanasius Kircher and the Plague Epidemic of 1656,' in *Athanasius Kircher, the Last Man who Knew Everything*, ed. Paula Findlen, (New York: Routledge, 2004), 63-78.
- 40 Harald Siebert, 'Kircher and his Critics: Censorial Practice and Pragmatic Disregard in the Society of Jesus,' in *Athanasius Kircher, the Last Man who Knew Everything*, ed. Paula Findlen, (New York: Routledge, 2004), 79-104).
- 41 Troncarelli, 'La paura dell'idra'; Baldwin, 'Reverie in the time of Plague'.
- 42 Francesco Redi, *Esperienze Intorno alla Generazione degl' Insetti, fatte da Francesco Redi, Gentiluomo Aretino e Accademico della Crusca, e da lui scritte in una Lettera all'Illustrissimo Signor Carlo Dati* (Florence: All'insegna della Stella, 1668).
- 43 See Note *supra*.
- 44 Svante Arrhenius, *Worlds in the Making: The Evolution of the Universe* (New York: Harper & Row, 1908).
- 45 Ella Reitsma, *Maria Sibylla Merian and Daughters: Women of Art and Science* (Los Angeles: Getty Publications, 2008).

